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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

LI, AIMEE J

ART UNIT PAPER NUMBER

2183

DATE MAILED: 06/16/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/761,217

Applicant(s)

CHAUDLHRY ET AL.

Examiner

Aimee J. Li

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 February 2005 and 28 March 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3-9, 12, 14-20 and 23 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 1 and 3-9 is/are allowed.
- 6) ☒ Claim(s) 12, 14-20 and 23 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: _____

DETAILED ACTION

1. Claims 1, 3-9, 12, 14-20 and 23 have been examined. Claims 1, 12, and 23 have been amended as per Applicant's request.

Papers Submitted

2. It is hereby acknowledged that the following papers have been received and placed on record in the file: After Final Amendment as received on 07 February 2005 and RCE as received on 28 March 2005.

Allowable Subject Matter

3. Claims 1 and 3-9 are allowed. The following is an examiner's statement of reasons for allowance: Claim 1 recites the limitations

Checking a read bit, wherein the read bit indicates whether a field within a data region associated with the section of code has been read by the speculative thread and, if so

Advancing the current time in the time dimension of the system, and

Determining if a different between the predicted result and the result

generated by the head thread affected execution of the speculative thread

4. The prior art has taught checking a read bit, advancing the current time, and determining if there is a difference between predicted and actual results separately. However, the prior art does not teach advancing the current time and determining if there is a difference between the predicted and actual results when a data region has been read by a speculative thread. Any comments considered necessary by applicant must be submitted no later than the payment of the

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issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Claim Rejections - 35 USC § 101

5. 35 U.S.C. 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

6. Claim 23 is rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. Claim 23 recites "a computer-readable storage medium" in the preamble. "Computer-readable storage medium" has been defined on page 7, lines 20-27 to include "instruction signals in a carrier wave". This is non-statutory material.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 12 and 14-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marcuello et al., *Value Prediction for Speculative Multithreaded Architectures* (hereinafter Marcuello(1)), and Marcuello et al., *Speculative Multithreaded Processors* (hereinafter Marcuello(2)), incorporated by reference in Section 2 of Marcuello(1), in view of Kumar et al., U.S. Patent Number 5,737,750 (herein referred to as Kumar).

9. Regarding claim 12, Marcuello has taught an apparatus that facilitates predicting a result produced by a section of code in order to support speculative program execution, the section of

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code including a plurality of program instructions (see Marcuello(2) Col.1 lines 11-16 and Col.2 line 47 – Col.3 line 9), the apparatus comprising:

- a. A head thread that is configured to execute the section of code within a program, wherein executing the section of code produces the result (see Marcuello(2) Col.5 lines 19-25),
- b. A prediction mechanism that is configured to generate a predicted result to be used in place of the result before the head thread produces the result (see Marcuello(2) Col.3 lines 2-9),
- c. A speculative thread that is configured to speculatively execute subsequent code within the program using the predicted result (see Marcuello(2) Col.3 lines 2-9 and Col.6 lines 14-20), wherein the subsequent code follows the section of code in an execution stream of the program (see Marcuello(2) Col.5 lines 26-29),
- d. A determination mechanism that is configured to determine if a difference between the predicted result and the result generated by the head thread affected execution of the speculative thread (see Marcuello(2) Col.4 lines 53-57 and Col.7 line 16 – Col.8 line16). Here, the NW field is updated, and subsequently checked, on every write operation to see if it has reached a value of zero, which happens when the difference between the predicted result and the head thread's result affected the speculative thread (see Marcuello(2) Col.7 line 48 – Col.8 line6).
- e. A joining mechanism that is configured to merge state associated with the speculative thread with state associated with the head thread if the difference did

not affect execution of the speculative thread (see Marcuello(2) Col.4 line 53 – Col.5 line 5 and Col.5 lines 26-35),

- f. Wherein if the difference affected execution of the speculative thread, the apparatus is configured to perform a rollback operation for the speculative thread to undo actions performed by the speculative thread (see Marcuello(2) Col.8 lines 7-11).

10. Here, the Applicant has described the above as the problem of a memory element having been read by the speculative result when it should have first been written by the head thread, causing erroneous results, and consequently either rolling back the speculative thread so it can be re-executed if there was a problem, or committing the thread if there was no problem (p.10 lines 3-23 of the specification). Marcuello has taught the comparing of the results of the head thread and the speculative thread, and either rolling back the speculative thread to be re-executed if the results were not equal (see Marcuello(2) Col.8 lines 7-11), or committing the thread if the results were the same (see Marcuello(2) Col.4 lines 53-57). Thus, Marcuello is operating in the same manner as the claim language has stated, in that if the speculative thread incorrectly reads the result of a write operation, it would produce erroneous results that would be detected in the thread comparison of Marcuello and consequently perform the proper action.

11. Marcuello(1 and 2) have not taught

- a. A checking mechanism that is configured to check a read bit, wherein the read bit indicates whether a field within a data region associated with the section of code has been read; and

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- b. A time advancing mechanism that is configured to advance the current time in the time dimension of the system.

12. Kumar has taught

- a. A checking mechanism that is configured to check a read bit, wherein the read bit indicates whether a field within a data region associated with the section of code has been read (Kumar column 4, line 66 to column 5, line 18 and Figure 4); and
- b. A time advancing mechanism that is configured to advance the current time in the time dimension of the system (Kumar column 5, lines 19-20).

13. A person of ordinary skill in the art at the time the invention was made would have recognized that the read bit and time mechanism of Kumar allows the data to be available to elements outside of the cache, thereby ensuring that the data can be used and manipulated. Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to incorporate the read bit and clock of Kumar to use and manipulate data in the cache.

14. Regarding claim 14 Marcuello has taught the apparatus of claim 12, wherein the determination mechanism is configured to determine if the speculative thread accessed the predicted result. Here, the Applicant has described the above as the problem of a memory element having been read by the speculative result when it should have first been written by the head thread, causing erroneous results, and consequently either rolling back the speculative thread so it can be re-executed if there was a problem, or committing the thread if there was no problem (p.10 lines 3-23 of the specification). Marcuello has taught the comparing of the results of the head thread and the speculative thread, and either rolling back the speculative thread to be

re-executed if the results were not equal (see Marcuello(2) Col.8 lines 7-11), or committing the thread if the results were the same (see Marcuello(2) Col.4 lines 53-57). Thus, Marcuello is operating in the same manner as the claim language has stated, in that if the speculative thread incorrectly reads the result of a write operation, it would produce erroneous results that would be detected in the thread comparison of Marcuello and consequently perform the proper action.

15. Regarding claim 15, Marcuello has taught the apparatus of claim 12, wherein the determination mechanism is configured to determine if the predicted result differs from the result generated by the head thread (see Marcuello(2) Col.4 lines 53-57).

16. Regarding claim 16, Marcuello has taught the apparatus of claim 12, wherein the prediction mechanism is configured to generate the predicted result by looking up a value based upon a program counter for the program (see Marcuello(1) Col.7 lines 14-20).

17. Regarding claim 17, Marcuello has taught the apparatus of claim 16, wherein the prediction mechanism is configured to generate the predicted result by additionally looking up the value based upon at least one previously generated value for the result (see Marcuello(1) Col.5 lines 22-38).

18. Claim 6 is nearly identical to claim 17, differing in its parent claim, but encompassing the same scope. Therefore, claim 6 is rejected for the same reasons as claim 17.

19. Regarding claim 18, Marcuello has taught the apparatus of claim 16, wherein the prediction mechanism is configured to generate the predicted result by performing a function on the value (see Marcuello(1) Col.5 lines 28-31).

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20. Regarding claim 19, Marcuello has taught the apparatus of claim 12, wherein the section of code includes one of a method, a function and a procedure (see Marcuello(1) Col.3 lines 24-33).

21. Regarding claim 20, Marcuello has taught the apparatus of claim 12, wherein the section of code is a body of a loop in the program, and the result is a loop carried dependency for the loop (see Marcuello(1) Col.4 line 37 – Col.5 line 7).

22. Claim 9 is nearly identical to claim 20, differing in its parent claim, but encompassing the same scope. Therefore, claim 9 is rejected for the same reasons as claim 20.

Response to Arguments

23. Applicant's arguments with respect to claims 12 and 14-20 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

24. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure as follows. Applicant is reminded that in amending in response to a rejection of claims, the patentable novelty must be clearly shown in view of the state of the art disclosed by the references cited and the objections made. Applicant must also show how the amendments avoid such references and objections. See 37 CFR § 1.111(c).

- a. Yuval Tamir's "Self-Checking Self-Repairing Computer Nodes Using the Mirror Processor" from IEEE Journal of Solid-State Circuits Vol. 27, No. 1, January 1992 has taught a roll-back method for error recovery by rolling-back the processor to a checkpoint, which is set every cycle.

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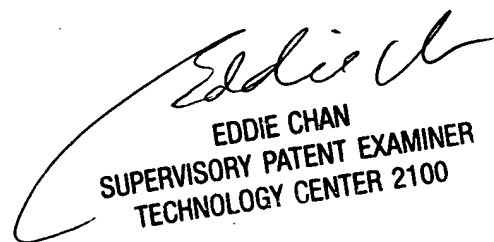
- b. Vijay Raghavengra and Chidchanok Lursinsap's "A Technique for Micro-Rollback Self-Recovery Synthesis" from IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, Vol. 14, No. 9, September 1995 has taught a roll-back method for error recovery.

25. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Aimee J. Li whose telephone number is (571) 272-4169. The examiner can normally be reached on M-T 7:30am-5:00pm.

26. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Chan can be reached on (571) 272-4162. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

27. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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09 June 2005


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